IS 4318 (1993): Solid core porcelain insulators for overhead traction lines [ETD 6: Electrical Insulators and Accessories]

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IS 4318 : 1993

( Reaffirmed 2003 )

भारतीय मानक

# शिरोपरि संकर्षण लाइनों के लिए ठोस कोड पोर्सलीन विद्युतरोधक — विशिष्टि

( पहला पुनरीक्षण )

*Indian Standard*

# SOLID CORE PORCELAIN INSULATORS FOR OVERHEAD TRACTION LINES — SPECIFICATION

*( First Revision )*

UDC 621·315·62 : [ 621·315·612·2 ] : 621·332·31



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*July* 1993

Price Group 9

## FOREWORD

This Indian Standard ( First Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

This standard was first issued in 1967 to meet the requirements of rapid electrification of railways. This standard provided the necessary guidance to the industry and the railways for supply and procurement of quality insulators for Indian Railways.

The major changes made during this revision are as follows:

a) *Dimensions* — Maximum permissible shed diameter of sectioning insulator has been increased from 130 mm to 135 mm and length from 500 mm to 580 mm. For bracket insulator also length has been increased from 500 mm to 550 mm. These changes have been made to obtain minimum specified creepage distance of 850 mm for these insulators. For 1 050 mm creepage distance insulators, the maximum shed diameter for stay-arm and bracket and 9 ton insulators have been increased to 225 mm and 235 mm respectively. Only minor changes have been made in the dimensions of caps.

   Because of special construction of these insulators and their use on traction lines exposed to heavily polluted atmospheres, the creepage distance are specified accordingly;

b) *Electrical characteristics* — Specification of one minute dry power frequency withstand voltages have been deleted in line with current international practice;

c) *Mechanical characteristics* — The values of routine tensile tests and one minute withstand values in mechanical test have been increased from 45 percent to 60 percent of the specified minimum failing value in line with current international standard [ IEC 383-1983 ];

d) Statistical quality control ( SQC ) parameters have been added which are required to be furnished by the manufacturer; and

e) Mass of zinc coating on the caps of polluted zone insulators has been specified as 1 000 g/m$^2$.

Considerable assistance has been derived from ETI/OHE/15 ( 11 83 ) RDSO 'Specification for Solid Core Porcelain Insulators for 25 kV, Single Phase, 50 Hz AC Traction Overhead Line Equipment', issued by Research Design and Standards Organization, Ministry of Railways, Lucknow.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values ( *revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# SOLID CORE PORCELAIN INSULATORS FOR OVERHEAD TRACTION LINES — SPECIFICATION

*( First Revision )*

## 1 SCOPE

This standard covers the requirements and method of tests for solid core porcelain insulators, both standard and for polluted zones, used on single phase electric traction lines having a nominal voltage of 25 kV ( line-earth ) ac at 50 Hz. The maximum system voltage may, however, go up to 27·5 kV.

## 2 REFERENCE STANDARDS

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

## 3 TERMINOLOGY

**3.0** For the purpose of this standard the following definitions in addition to those given in IS 1885 ( Part 54 ) : 1980 shall apply.

### 3.1 Solid Core Porcelain Insulator

An insulator consisting of a porcelain element of solid core construction and associated metal fittings intended to give support to a live part which is to be insulated from earth or from another live part.

### 3.2 Stay Arm Insulator

The insulator which forms part of the horizontal member, known as the stay arm of the cantilever assembly from which the traction conductors are suspended, and which insulates that member from the mast or structure to which the cantilever is attached.

### 3.3 Bracket Insulator

The insulator which forms part of the inclined member, known as the bracket, of the cantilever assembly from which the traction conductors are suspended and which insulates that member from the mast or structure to which the cantilever is attached.

### 3.4 9-Tonne Insulator

The insulator which has a nominal tensile breaking load of nine tonnes and is normally, though not exclusively, used as a strain insulator for anchoring of conductors. It is also used in a vertical position to support 25 kV feeder wire.

### 3.5 Post Insulator

It is used for supporting rigidly, live contacts of 25 kV insulator switches or the 25 kV bus bars at switching stations.

### 3.6 Sectioning Insulator

The insulating element of a piece of equipment which is used for separating adjacent sections of traction line belonging to different elementary electrical sections in the normal conditions and which provides a continuous mechanical and electrical path for the passage of pantographs of electrical rolling stock.

### 3.7 Operating Rod Insulator

The insulator used for the operating rod of 25 kV insulator, for opening or closing isolators which are manually or motor operated.

### 3.8 Standard Insulator

The insulators used in lightly polluted or unpolluted zones are termed standard insulators.

### 3.9 Polluted Zone Insulator

The insulator used in medium and heavily polluted zones are termed 'Polluted Zone' insulators. Although polluted zones are normally classified in 4 categories, only 2 types of insulators are specified to reduce the type of insulators.

NOTE — The classification of polluted areas, the determination of pollution severity and selection of standards and polluted zone insulators are given in IS 13134 : 1992.

### 3.10 Dry Lightning Impulse Withstand Voltage

The lighting impulse voltage which the insulator withstands dry, under the conditions prescribed in **11.6**.

### 3.11 50 Percent Dry Lightning Impulse Flash Over Voltage

The value of the lightning impulse voltage which, under the prescribed conditions of tests, has a 50 percent probability of producing flash over on the insulators dry.

### 3.12 Wet Power Frequency Withstand Voltage

The power frequency voltage which the insulator withstands wet, under the test conditions prescribed in **11.7**.

### 3.13 Wet Power Frequency Flashover Voltage

The lowest value of the 50 Hz voltage which causes flash over of the insulator under the conditions prescribed in **11.7** within 60 seconds.

### 3.14 Mechanical Failing Load

The maximum load which can be reached when an insulator is tested under the prescribed conditions of test.

**3.14.1** It corresponds to the maximum load which can be applied to the insulator without causing separation or breakage of metal parts, or any permanent deformation in the insulator assembly and its components.

### 3.15 Creepage Distance

The shortest distance along the contours of the external surfaces of the ceramic insulating part of the insulator between those parts which normally have the operating voltage between them. The distance measured over the surface of cement shall not be considered as forming part of the creepage distance.

**3.15.1** If high resistance coatings are applied to the parts of the insulator, such coatings shall be considered as effective insulating surfaces and distances over them shall be included in the creepage distance. The surface resistivity of such high resistance coatings is usually about $10^6$ Ohms, but may be as low as $10^4$ Ohms.

### 3.16 Lot for Acceptance Test

All the insulators of the same type and design manufactured under similar conditions of production, offered for acceptance. A lot may consist of the whole or part of the quantity ordered.

### 3.17 Type Tests

Tests carried out to prove conformity with the specification. These are intended to prove the general quality and design of a given type of insulator.

### 3.18 Acceptance Tests

Tests carried out on sample taken from the lot for the purpose of the acceptance of the lot.

### 3.19 Routine Tests

Tests carried out on each insulator to check requirements which are likely to vary during production.

## 4 STANDARD ATMOSPHERIC CONDITIONS

**4.1** Standard atmospheric condition for tests at which insulator characteristics shall be expressed for the purpose of comparison shall be as given below:

| | |
|---|---|
| Ambient temperature | 20°C |
| Barometric pressure | 1 013 millibars |
| Absolute humidity | 11 g of water per cubic meter corresponding to 63 percent relative humidity at 20°C |

NOTES

1 A pressure of 1 013 millibars is equivalent to a pressure of 760 mm of mercury at 0°C. If the height of the barometer is $h$ mm of mercury and the temperature of the mercury is $t$°C, the atmospheric pressure in millibars is:

$$p = \frac{1\,013\,h}{760}\,(1 - 1{\cdot}80 \times 10^{-4}\,t)$$

2 The Indian Standard reference temperature of 27°C and corresponding humidity have not been specified because of the non-availability of the test voltage values and correction factors for these conditions. These conditions will replace those specified above when the corresponding test voltage values and correction factors are available.

**4.2** The tests may, however, be carried out under conditions naturally obtaining at the time of the tests. The barometric pressure, air temperature and humidity shall be recorded for the purpose of corrections. Corrections of test voltages for atmospheric conditions shall be carried according to Annex B.

## 5 MATERIALS AND CONSTRUCTION

### 5.1 Porcelains

The porcelain shall be sound, free from defects, thoroughly vitrified and fully glazed. The 9-tonne insulator ( both standard and polluted zone ), sectioning insulator and post insulator shall be manufactured from alumina only. The other types of insulators shall preferably be manufactured from alumina.

The quality of the porcelain shall be such that it shall withstand flashover, at the maximum arc current of 6 kA for 0·2 sec followed by 2 kA for 0·2 sec, followed after a pause of 60 sec by a further 6 kA for 0·2 sec without parting.

#### 5.1.1 *Glass*

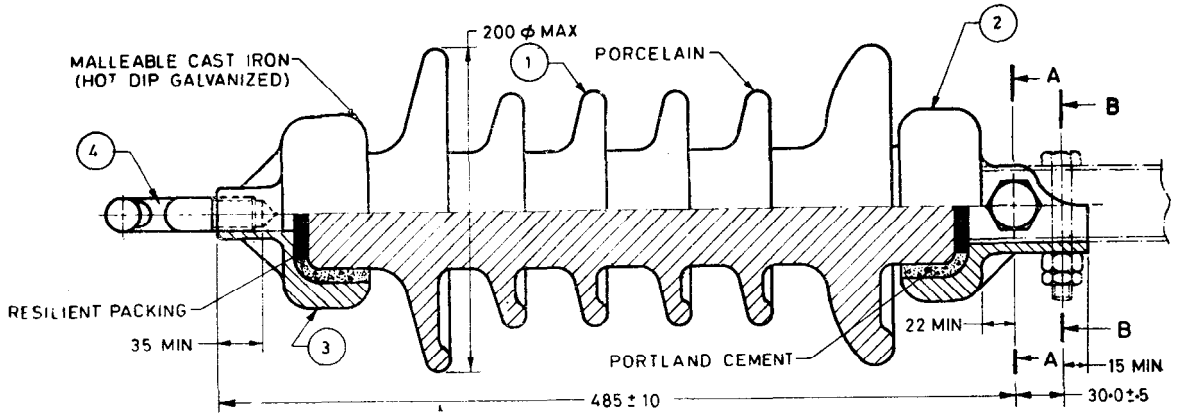
The glass, unless otherwise specified, shall be brown in colour. The glaze shall cover all the porcelain parts of the insulator except those areas which serve as support during firing or are purposely left unglazed.

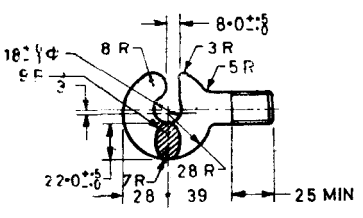
**5.1.2** *Shed Profiles*

The sheds will be provided with lips at the extremities for all types of insulators, except sectioning insulator which has symmetric shed profile.

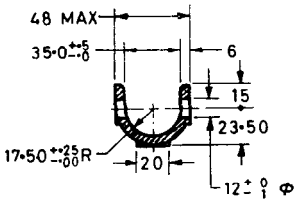
The shed profile shall be simple, free from ribs on the underside to avoid accumulation of dust and pollutants. The profiles indicated in Fig. 1 to Fig. 9 are for the guidance of manufacturers. The dimensions given in the figures are required to be followed from the point of view of interchangeability. Alternative shed profiles may be provided if agreed between the manufacturer and the user.

**5.1.3** The shed profiles shall meet the guidelines prescribed in IS 13134 : 1992.

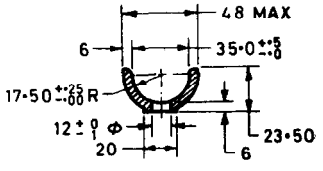



FORGED STEEL (HOT DIP GALVANIZED)




SECTION AA



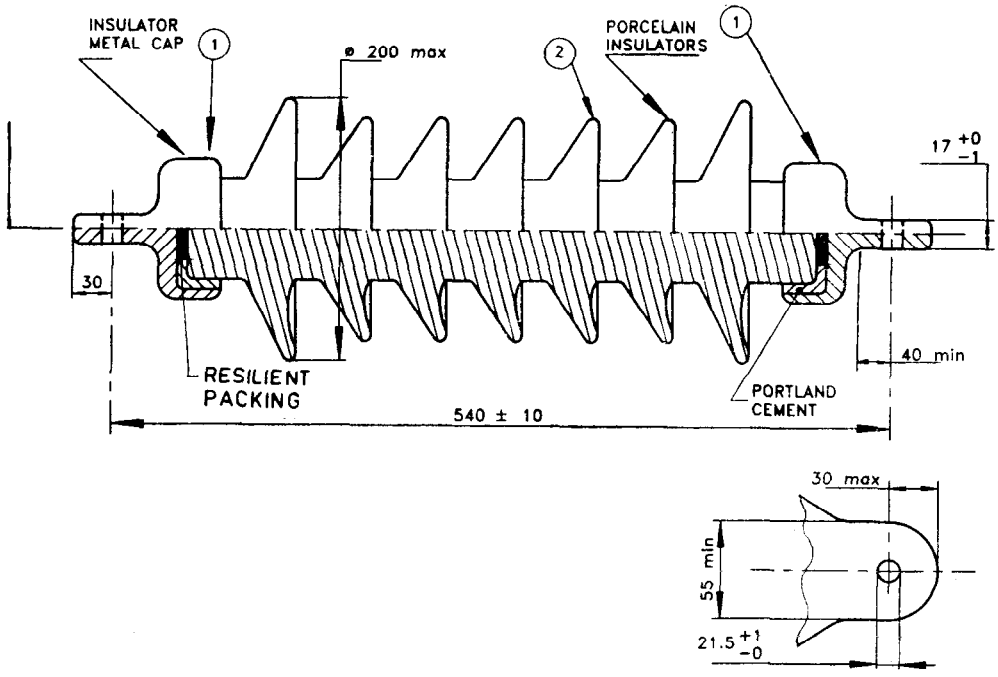

SECTION BB

NOTES

1 All dimensions in millimetres.
2 Threads as per IS 4218.
3 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8394 : 1977.
4 Creepage distance 850 mm, *Min*.

| Ref No. | Description | Material | Protection Against Rusting |
|---|---|---|---|
| 1. | Stay arm insulator ( Porcelain ) | Porcelain | — |
| 2. | Stay arm insulator tube cap | Black heart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 3. | Stay arm insulator hook cap | Porcelain | — |
| 4. | Stay arm insulator hook | Forged steel grade 35 Mn6 No. 3 of IS 5517 : 1978 ampered to achieve tensile strength of 800 to 900 N/mm² | Hot dip galvanized |

FIG. 1 STAY-ARM INSULATOR ( STANDARD ) ( CREEPAGE DISTANCE — 850 mm *Min* )




NOTES

1 The caps are identical and parallel to each other.

2 All dimensions in millimetres.

3 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8394 : 1977.

4 Creepage distance 850 mm, *Min.*

| Ref No. | Description | Material | Protection Against Rusting |
|---|---|---|---|
| 1. | Tonne insulator cap | Blackheart Malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2 | Tonne insulator | Porcelain | |

FIG. 2 9-TONNE INSULATOR ( STANDARD )

**5.1.4** The end portion of porcelain shells may be straight sanded or conical unsanded. The angle of porcelain at the end shall be between 4° and 12°. Similarly, the angle of the cap shall be between 4° and 12°.

### 5.2 Metal Caps

The metallic end caps shall be made of black heart malleable cast iron conforming to Gr BM-340 of IS 2108 : 1977 or any other grade or material with the prior agreement between the manufacturer and the user. The casting shall be sent blasted before and after heat treatment.

### 5.3 Metal Hook

The material for hook of the stay-arm insulator shall conform to steel designation 35 Mn6 Mo3 of IS 5517 : 1978 tempered to achieve tensile strength 800 to 950 N/mm² [ *see* also IS 1367 ( Part 16 ) : 1979 ].

### 5.4 Protection Against Rusting

All ferrous metal parts, except those of stainless steel, shall be hot-dip galvanized in accordance with IS 4759 : 1984.

The minimum weight of coating shall be as below excluding tapped and threaded portions:

All standard insulators.....610 g/m²

All polluted zone insulators excepting hook of stay arm.....1 000 g/m²

Hook of polluted zone insulators.....750 g/m².

The uniformity of zinc coating shall satisfy the requirements of IS 2633 : 1986. The parts shall be galvanized after machining. The finished galvanized surface shall be smooth.

NOTE — The threads of the tapped holes in the post and operating rod insulator metal fitting may be cut after galvanization. These threads shall be protected against corrosion by application of suitable grease. Threads of female holes of all metal parts may be cut after galvanizing and they shall be greased to avoid corrosion. Threads of all other metal components shall be cut before galvanization. The tapped holes shall be suitable for bolts with threads having galvanization and shall conform to IS 4218 ( Parts 1 to 6 ). When not otherwise specified, the effective length of the threads shall not be less than the nominal diameter of the bolt.

### 5.5 Cementing Material

The end caps shall be fixed to the porcelain body with portland cement. The cement used in the construction of the insulator shall not cause fracture by expansion or loosening by contraction. Cement shall be such as not to react chemically with the metal fittings and its thickness shall be as uniform as possible. The porcelain body shall be centrally located in the cap by suitable jigs during cementing and no part of porcelain shall come in contact directly with the metallic cap. Cork sheet or thick paper shall be used between the metallic caps and the end of porcelain shell to prevent impact load on the porcelain shell.

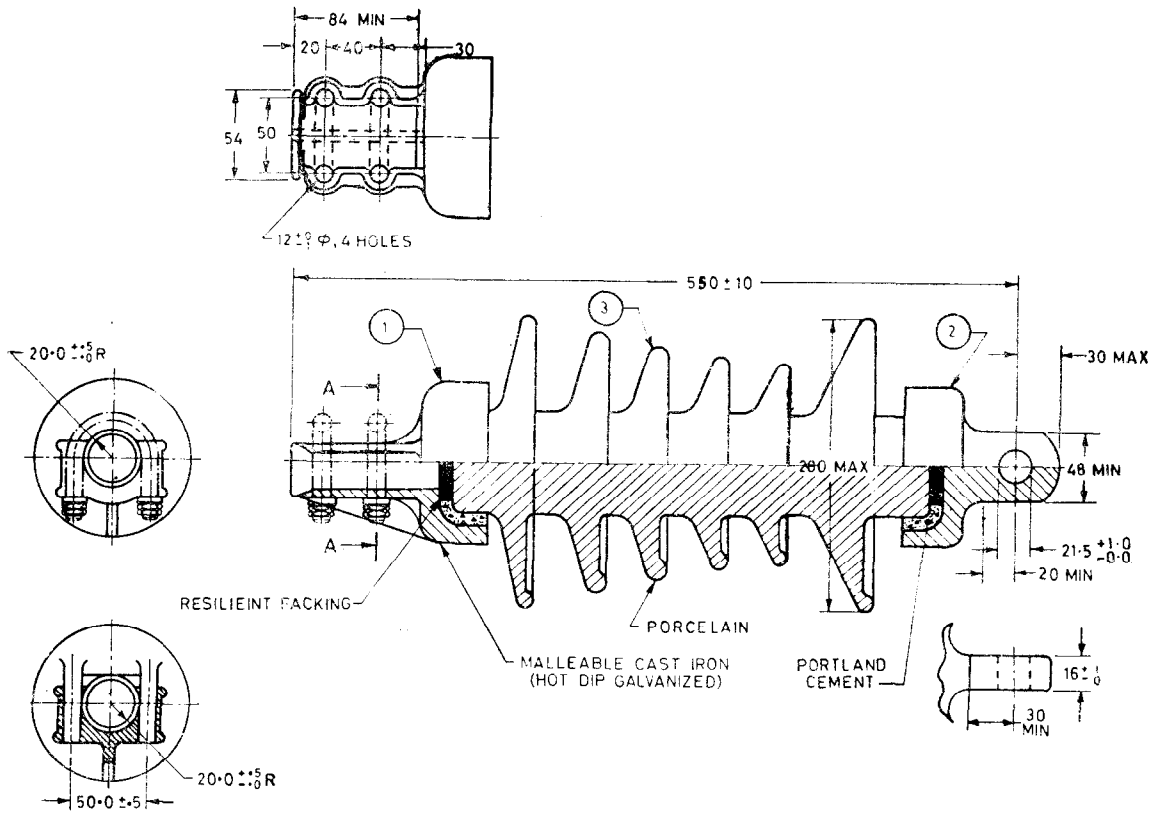
### 5.6 Construction

The tongues of the two caps of 9-tonne insulators shall be parallel, the tongue of bracket insulator shall be at right angles to the tube side cap. The faces of operating rod and post insulators shall be parallel to each other and at right angles to the axis of the insulator.

## 6 TEST VOLTAGES

**6.1** The test voltages for both standard and polluted zone insulators are given in Table 1.

**6.2** The power frequency voltages shall be expressed as peak values divided by 2. The impulse voltage shall be expressed as peak values.




SECTION AA (WITHOUT U BOLT)

NOTES

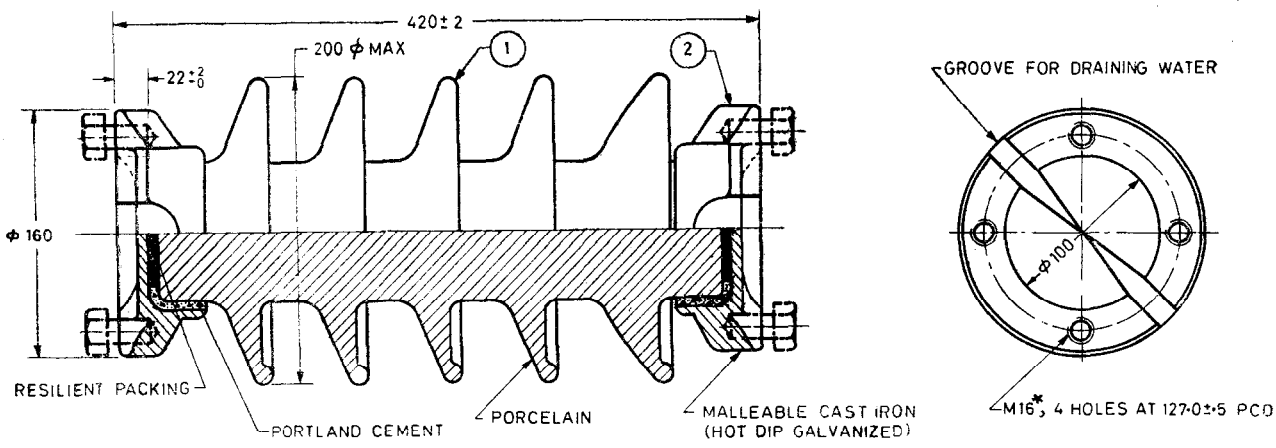
1 All dimensions in millimetres.

2 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.

3 Creepage distance 850 mm, *Min.*

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Bracket insulator tube cap | Blackheart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Bracket insulator standard cap | — | — |
| 3. | Bracket insulator | Porcelain | — |

FIG. 3 BRACKET INSULATOR ( STANDARD )




NOTES

1 Threads according to IS 4218.

2 All dimensions in millimetres.

3 The caps are identical and parallel to each other.

4 Tolerances of untoleranced dimensions for MCI caps as per class 1 of IS 8349 : 1977.

5 Creepage distance 850 mm, *Min*.

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Post insulator cap | Blackheart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Post insulator body | Porcelain | — |

FIG. 4 POST INSULATOR

**6.3** The withstand and flashover voltage are referred to the reference atmospheric conditions ( *see* **4** ).

## 7 PERFORMANCE IN ARTIFICIAL POLLUTION TEST

The insulator when subjected to artificial pollution test to solid layer steam fog method procedure given in **17.1** of IS 8704 : 1978 shall withstand 30 kV for 15 minutes at ESDDs of 0·05 mg/cm² for normal insulator when tested in accordance with **11.8**.

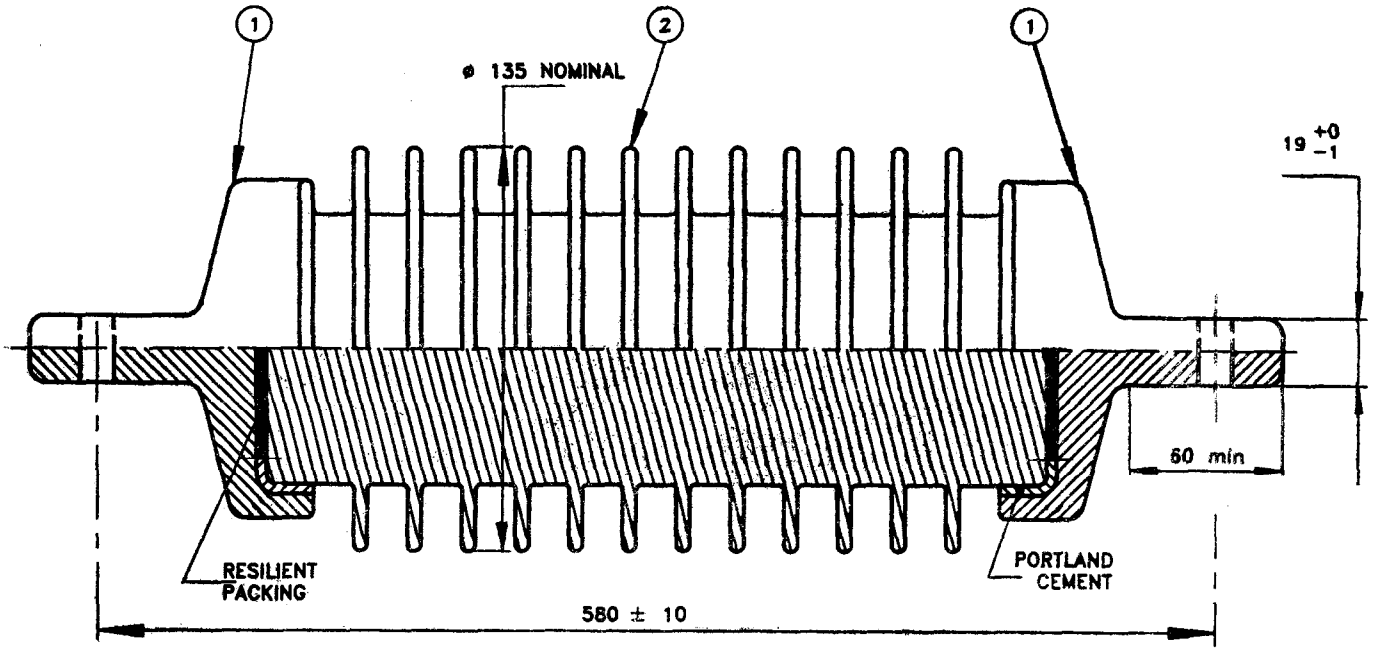
## 8 MECHANICAL LOADS

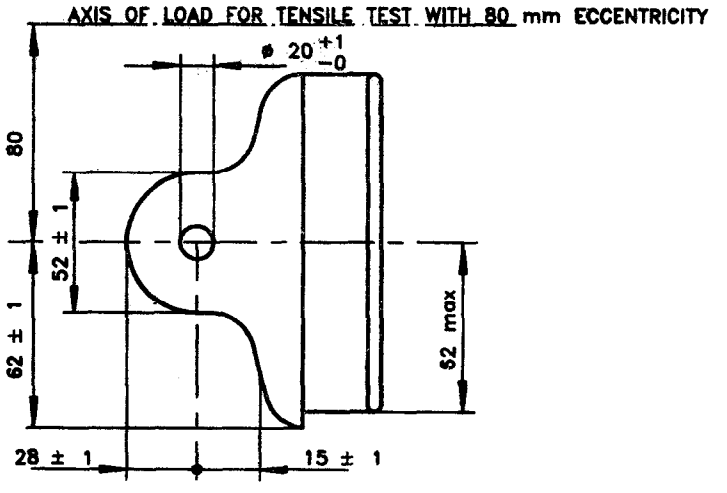
**8.1** The minimum failing load of insulators shall be in accordance with Table 2.

**Table 1 Test Voltages**

( *Clauses* 6.1, 11.5.1, 11.6.1.2 *and* 11.7.3 )

| Type | Power Frequency Voltage ( Visible Discharge Test ) | One-Minute-Wet Power Frequency Withstand Test | | 1·2/50 Micro Second Impulse Voltage Withstand Test | |
|---|---|---|---|---|---|
| | | Insulator Vertical | Insulator Horizontal | Positive Wave | Negative Wave |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | kV ( rms ) | kV ( rms ) | kV ( rms ) | kV ( peak ) | kV ( peak ) |
| Stay arm Insulator | 35 | 100 | 125 | 240 | 260 |
| 9-tonne insulator | 35 | 100 | 125 | 240 | 260 |
| Bracket insulator | 35 | 100 | 125 | 240 | 260 |
| Post insulator | 35 | 100 | — | 240 | 260 |
| Sectioning insulator | 35 | — | 125 | 240 | 260 |
| Operating rod insulator | 35 | 100 | 125 | 240 | 260 |




NOTES

1 The caps are identical to each other.

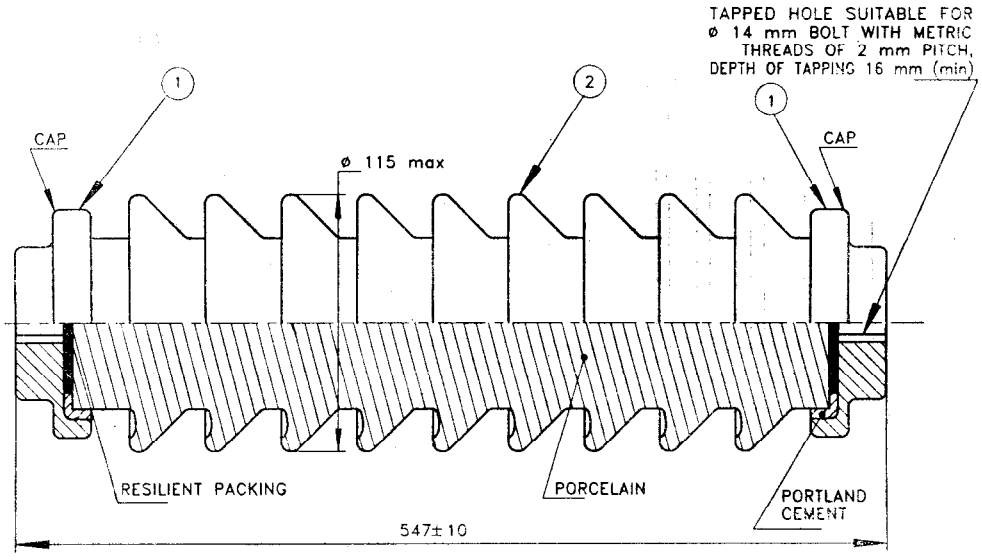
2 All dimensions in millimetres.

3 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.

4 Creepage distance 850 mm, *Min*.

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Sectioning insulator cap | Blackheart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Sectioning insulator | Porcelain | |

FIG. 5 SECTIONING INSULATOR

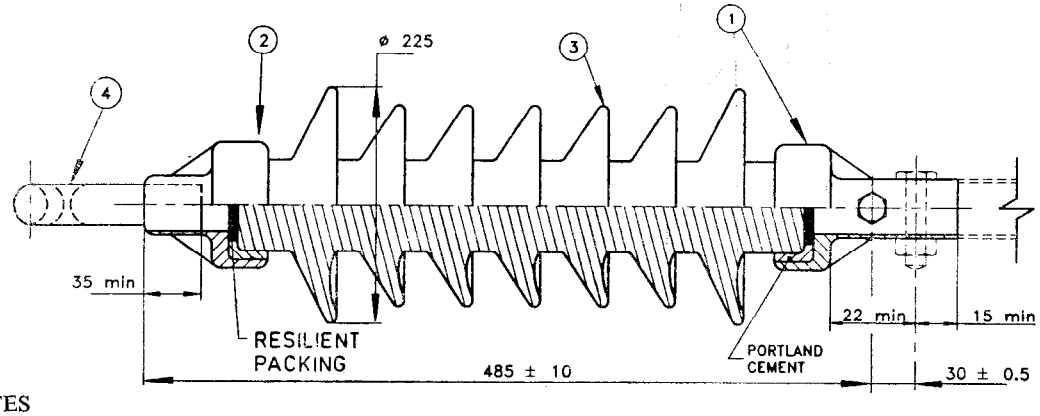



NOTES

1 All dimensions in millimetres.
2 The caps are identical and parallel to each other.
3 Threads according to IS 4218.
4 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.
5 Creepage distance 850 mm, *Min.*

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Operating rod insulator cap | Black heart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Operating rod insulator | Porcelain | — |

FIG. 6 OPERATING ROD INSULATOR

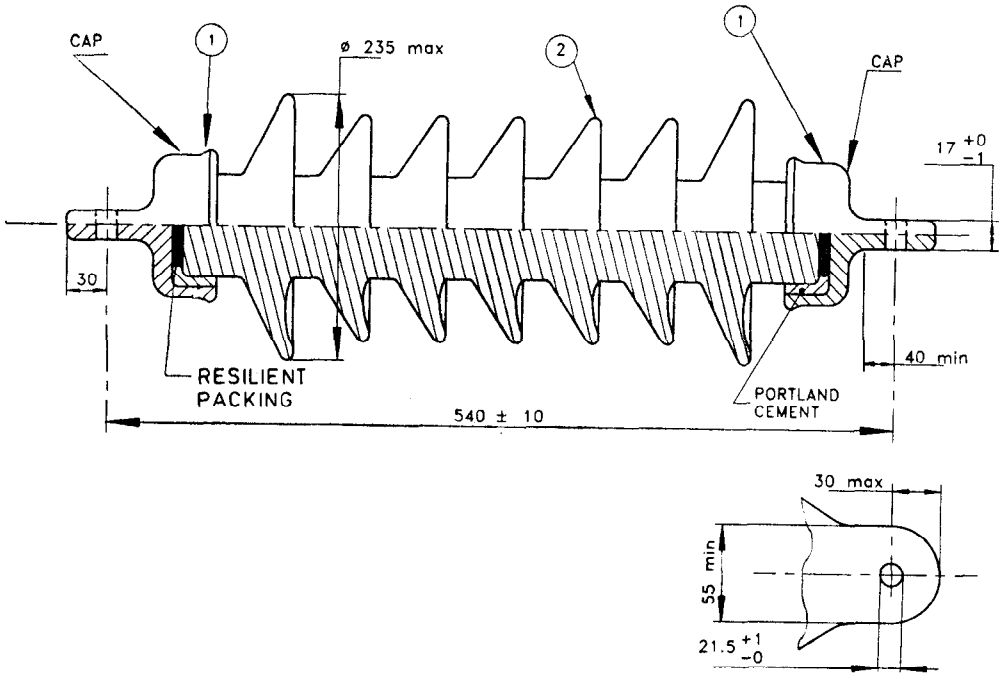



NOTES

1 Hook and cap details same as shown in standard stay arm insulator ( *see* Fig. 1 ).
2 Threads according to IS 4218.
3 All dimensions in millimetres.
4 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.
5 Creepage distance 1 050 mm, *Min.*

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Stay arm insulator tube cap | Blackheart malleable cast iron grade BM 340 of IS 2108 | Hot dip galvanized |
| 2. | Stay arm insulator hook cap | do | do |
| 3. | Stay arm insulator | Porcelain | — |
| 4. | Stay arm insulator hook | Blackheart malleable cast | Hot dip galvanized |

FIG. 7 STAY ARM INSULATOR




NOTES

1 The caps are identical and parallel to each other.

2 All the sheds may be of equal diameter.

3 All dimensions in millimetres.

4 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.

5 Creepage distance 1 050 mm, *Min*.

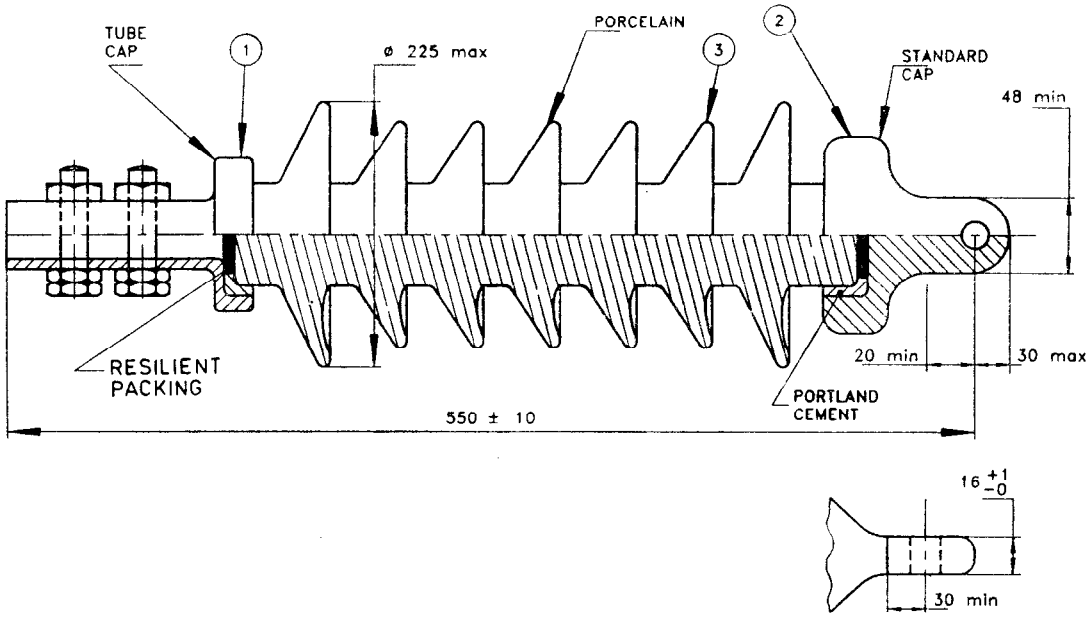
| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Tonne insulator cap | Blackheart malleable cast iron grade BM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Tonne insulator | Porcelain | — |

FIG. 8 9-TONNE INSULATOR ( POLLUTED ZONES )

## Table 2 Minimum Failing Loads

( *Clauses* 8.1, 11.10.1.1, 11.10.1.2, 11.10.1.3 *and* 11.10.1.4 )

| Type | Tension Minimum | Tension with 80 mm Eccentricity of Load | Bending Torsion | |
|---|---|---|---|---|
| | kgf | kgf | kgf-m ( moment ) | kgf-m ( moment ) |
| (1) | (2) | (3) | (4) | (5) |
| Stay arm insulator | 5 400 | — | 100 | — |
| 9-tonne insulator | 9 900 | — | 210 | — |
| Bracket insulator | 5 400 | — | 170 | — |
| Post insulator | 6 000 | — | 370 | 550 |
| Sectioning insulator | — | 5 000 | — | — |
| Operating rod insulator | 2 200 | — | 70 | — |




NOTES

1 Cap details same as shown in standard bracket insulator ( *see* Fig. 3 ).

2 All dimensions in millimetres.

3 Tolerances of untoleranced dimensions for MCI caps as per class I of IS 8349 : 1977.

4 Creepage distance 1 050 mm, *Min*.

| Ref No. | Description | Materials | Protection Against Rusting |
|---|---|---|---|
| 1. | Bracket insulator tube cap | Blackheart malleable cast iron grade EM 340 of IS 2108 : 1977 | Hot dip galvanized |
| 2. | Bracket insulator standard cap | do | — |
| 3. | Bracket insulator | Porcelain | — |

FIG. 9 BRACKET INSULATOR ( POLLUTED ZONES )

## 9 DIMENSION AND CREEPAGE DISTANCES

### 9.1 Dimensions

The dimensions of the solid core insulators essential from the point of view of interchangeability shall be in accordance with Fig. 1 to Fig. 9.

### 9.2 Creepage Distance

The minimum creepage distance of the insulator shall be as given in Table 3.

## 10 MARKING

**10.1** Each insulator shall be legibly and indelibly marked both on the porcelain and on the cap to show the following:

a) Name or trade mark of the manufacturer,

b) Month ( optional for the caps ) and year of manufacture, and

c) Any other identification marks specified by the purchaser.

**10.2** Marking on porcelain shall be printed and shall be applied before firing. Marking on the cap shall be in relief and provided during casting itself.

**10.2.1** Insulators may also be marked with the Standard Mark.

## 11 TESTS

### 11.1 General

**11.1.1** *Type Tests*

The following shall constitute the type tests:

a) Examination of assembly ( **11.2** ),

b) Verification of dimensions ( **11.3** ),

c) Visual examination ( **11.4** ),

d) Visible discharge test ( **11.5** ),

e) Impulse withstand voltage test ( **11.6** ),

f) Wet power-frequency voltage test ( **11.7** ),

— One minute withstand test

— One minute maximum withstand test

g) Artificial pollution test ( **11.8** ),
h) Temperature cycle test ( **11.9** ),
j) Mechanical load test ( **11.10** ),
k) Mechanical performance test ( **11.11** ),
m) Thermal-mechanical performance test ( **11.12** ),
n) Porosity test ( **11.13** ),
p) Ultrasonic test ( **11.14** ),
q) Galvanizing test on the metallic and caps ( **11.15** ), and
r) Verification of eccentricity ( **11.16** ).

**Table 3 Minimum Creepage Distance**

( *Clause* 9.2 )

| Type | Minimum Creepage Distance (mm) |
|---|---|
| *Standard ( Lightly Polluted ) Zone* | |
| Stay arm insulator | 850 |
| 9-tonne insulator | 850 |
| Bracket insulator | 850 |
| Post insulator | 850 |
| Sectioning insulator | 850 |
| Operating rod insulator | 850 |
| *Polluted Zone* | |
| Stay arm insulator | 1 050 |
| 9-tonne insulator | 1 050 |
| Bracket insulator | 1 050 |

**11.1.1.1** *Number of samples for type tests*

Artificial pollution test shall be conducted on one sample of each type. Each of the mechanical test except thermomechanical performance test shall be conducted on 10 samples of each type of insulator. The thermomechanical performance test shall be conducted on 3 samples of each type. The remaining tests may be conducted on 3 samples of each type.

**11.1.2** *Acceptance Tests*

**11.1.2.1** The acceptance tests shall be as follows:

a) Examination of assembly ( **11.2** ),
b) Verification of dimensions ( **11.3** ),
c) Visual examination ( **11.4** ),
d) Temperature cycle test ( **11.9** ),
e) Mechanical load test ( **11.10** ),
f) Mechanical performance test ( **11.11** ),
g) Porosity test ( **11.13** ),
h) Galvanization test ( **11.15** ), and
j) Verification of eccentricity ( **11.16** ).

**11.1.2.2** *Sampling plan*

The number of insulators for acceptance testing to be selected at random from the lot offered, shall be in accordance with the Table 4.

**Table 4 Sampling Plan for Acceptance Test**

| Item | Lot Size | Number of Samples |
|---|---|---|
| Stay Arm, Bracket and Operating Rod; 9-tonne | Less than 800 | 15 |
| | 801 to 3 200 | 30 |
| | 3 201 to 8 000 | 25 |
| | 8 001 and above | 30 |
| Sectioning Insulators | Less than 500 | 10 |
| | 501 to 800 | 15 |
| | 801 to 3 200 | 25 |
| Post Insulators | Less than 500 | 15 |
| | 501 to 800 | 25 |
| | 801 to 3 200 | 35 |

**11.1.2.3** The insulator selected in accordance with **11.1.2.2** shall be subjected to different tests as under:

a) Three samples shall be first subjected to tests in **11.2**, **11.3** and **11.4**;
b) Then all the samples shall be subjected to temperature cycle test ( **11.9** );
c) If these samples pass the temperature cycle test, then they shall be subjected to mechanical and other tests of **11.1.2.1**. The distribution of samples for different mechanical tests shall be as per Table 5; and
d) All samples shall be subjected to test in **11.13** and half the number of samples shall be subjected to test in **11.15** ( equally for uniformity of zinc coating and mass of coating ). Three samples shall be subjected to test in **11.16**.

Fragements of porcelains from all insulators shall be subjected to porosity test ( **11.1.3** ).

**11.1.2.4** *Criteria of acceptance*

The criteria of acceptance of the lot shall be as follows:

a) If any insulator fails in the porosity test ( **11.13** ) or in agreed mechanical tests ( **11.10** and **11.11** ) at less than the minimum specified value, the lot shall be rejected.
b) If the quality factor in the mechanical test is equal to or more than the ACCEPTANCE QUALITY LEVEL given by the purchaser and the results of other tests are satisfactory, the lot shall be accepted.

c) However, if the results of other than the mechanical tests are not satisfactory, double the number of sample pieces shall be subjected to the particular test(s) in which the sample failed. If all the samples in double sampling meet the requirement of specification and the lot is otherwise acceptable, the lot shall be accepted.

**11.1.3** *Routine Tests*

The following shall be carried out as routine tests by the manufacturer. Records of insulators tested and numbers rejected shall be maintained:

a) Visual examination ( **11.4** ),

b) Routine mechanical load test ( **11.10.1.5** ),

c) Routine porosity test ( **11.13.2** ), and

d) Ultrasonic test ( **11.14** ).

NOTES

1 The routine mechanical test may be performed in the presence of the purchaser, if so desired.

2 A proposal to substitute the routine mechanical ( tensile ) test by a routine uniform bending test is under consideration. It is felt that the routine uniform bending test, conducted on porcelain shells before assembly of end caps would be more effective in eliminating defective insulators.

## 11.2 Examination of Assembly

**11.2.1** Assembly shall be examined to verify that the cement completely fills the space between the metal fittings and the ends of the insulator body and see that the metal fittings are well centered on the insulator. The exposed surface of cement shall not show any sign of crack or blow hole.

## 11.3 Verification of Dimensions

**11.3.1** It shall be verified that the insulator is in accordance with the relevant drawings of the user. Unless otherwise specified a tolerance of $\pm$ ( 0·03 $d$ + 0·3 ) mm shall be allowed for all dimensions of porcelain, $d$ being the dimensions in mm.

## 11.4 Visual Examination

**11.4.1** *General*

A visual examination of the insulator shall be made. The insulator shall be free from physical distortion of shape and the vitrified glaze shall be hard and smooth, free from cracks or any other defect likely to be prejudicial to satisfactory performance in service.

**11.4.2** *Glaze*

The whole surface of the insulator shall be covered with glaze which shall be perfectly vitrified and free from any streaks, cracks, flaws, bubbles or foreign bodies.

**Table 5 Distribution Plan for Mechanical Tests**

[ *Clause* 11.1.2.3 (c) ]

| Item | No. of Samples | Distribution of Samples | |
|---|---|---|---|
| Stay arm, bracket operating rod and 9-tonne insulator | 15 | Bending test | 5 |
| | | Tensile test | 5 |
| | | Mechanical performance test | 5 |
| | 20 | Bending test | 10 |
| | | Tensile test | 5 |
| | | Mechanical performance test | 5 |
| | 25 | Bending test | 15 |
| | | Tensile test | 5 |
| | | Mechanical performance test | 5 |
| | 30 | Bending test | 20 |
| | | Tensile test | 5 |
| | | Mechanical performance test | 5 |
| Sectioning Insulators | 10 | Eccentric tensile test | 5 |
| | | Mechanical performance test | 5 |
| | 15 | Eccentric tensile test | 10 |
| | | Mechanical performance test | 5 |
| | 20 | Eccentric tensile test | 15 |
| | | Mechanical performance test | 5 |
| Post Insulator | 15 | Bending test | 5 |
| | | Torsion test | 5 |
| | | Mechanical performance test | 5 |
| | 25 | Bending test | 10 |
| | | Torsion test | 10 |
| | | Mechanical performance test | 5 |
| | 35 | Bending test | 15 |
| | | Torsion test | 15 |
| | | Mechanical performance test | 5 |

**11.4.2.1** The glaze defects shall not exceed the limits applicable to the appropriate class of insulator specified in IS 13305 : 1992.

**11.4.3** *Assembly*

The cementing material shall extend to the level of the edge of the fitting or shall terminate above or below this level by not more than 2 mm.

**11.4.4** The metallic end fittings should be smooth and should not have any excrescence.

**11.4.5** The metallic end fittings should be inspected for quality of galvanization. The galvanization shall be free from defects as laid down in IS 4759 : 1979.

**11.5 Visible Discharge Test ( Power-Frequency Voltage )**

**11.5.1** The test room shall be darkened and a period of five minutes shall be allowed for the observer to become accustomed to darkness. A power frequency test voltage of the specified value ( *see* Table 1 ) corrected as per Annex B shall be applied in accordance with Annex C and maintained at this value for five minutes. During this time, observations shall be made and there shall be no sign of visible corona. The voltage shall then be raised gradually, and the value at which corona appears shall be recorded. Voltage shall then be reduced gradually, and the value at which the corona disappears shall be recorded.

**11.6 Lighting Impulse Votage Test**

Either of the following two alternative procedures may be adopted:

a) The withstand procedure with 15 impulses; or

b) The withstand calculated from the 50 percent flashover test.

**11.6.1** *Lightning Impulse Voltage Withstand Test Using the Withstand Procedure*

**11.6.1.1** The insulator shall be tested dry under the conditions prescribed in Annex C. The insulator shall be tested with 1·2/50 microsecond impulse voltage of both positive and negative polarity.

**11.6.1.2** The value of the specified impulse voltage ( *see* Table 1 ) shall be corrected in accordance with Annex B.

**11.6.1.3** Fifteen impulses shall be applied. If the number of flash overs on the external insulation does not exceed two, the insulator is deemed to comply with this standard.

The insulators shall not be damaged by these tests, but slight marks on the surface of the insulating parts or chipping of the cement used for assembly shall be permitted.

**11.6.2** *Lightning Impulse Voltage Withstand Testing Using the 50 Percent Flashover Procedure*

**11.6.2.1** The 50 percent impulse flash-over voltage shall be determined under the conditions prescribed in Annex C.

**11.6.2.2** The 50 percent impulse flashover voltage shall be determined by the following procedure:

A voltage $U_k$ is chosen, believed to lie at or near the 50 percent flashover voltage level. A voltage interval $\triangle U$ approximately 3 percent of $U_k$ is also chosen. One impulse is applied at the level $U_k$; if this does not cause flashover, the level of the next impulse should be $U_k + \triangle U$. If flashover occurs at the level $U_k$, the next impulse should have a level $U_k - \triangle U$.

The procedure is repeated a number of times, each impulse having a level determined by the effect of the proceeding impulse. The number of impulse $n_v$ applied at each voltage level $U_v$ is counted and the 50 percent flashover voltage is determined by the formula:

$$U_{50\%} = \frac{\Sigma n_v U_v}{\Sigma n_v}$$

In this formula, the first level taken into account should be one at which two or more impulses were applied. This partially corrects for the error which may be introduced if $U_k$ is much too low or much too high. The total number of impulse taken into account ( $\Sigma n_v$ ) shall be equal to 30.

The insulator passes, the test if the 50 percent impulse flashover voltage is not less than $\frac{1}{1 - 1{\cdot}3\sigma} = 1{\cdot}040$ times the specified in impulse withstand voltage, where $\sigma$ is standard deviation assumed equal to 3 percent.

The insulator shall not be damaged by these tests; but slight marks on the surface of the insulating parts or chipping of the cement or other material used for assembly shall be permitted.

**11.6.2.3** The impulse flashover voltages to be recorded shall be positive and negative 50 percent impulse flashover voltages measured in accordance with **11.6.2.2** corrected in accordance with Annex B.

**11.7 Wet One Minute Power Frequency Voltage Withstand Test and Wet One Minute Power-Frequency Maximum Voltage Withstand Test**

**11.7.1** The insulator shall be tested under the conditions prescribed in Annex C.

**11.7.2** Before commencement of the test, the insulator shall be exposed to the artificial rain produced in accordanee with **3.3** of IS 2071 ( Part 1 ) : 1974.

**11.7.3** The value of the test voltage shall be specified ( *see* Table 1 ) and corrected from the atmospheric conditions ( *see* Annex B ).

**11.7.4** The voltage shall be applied for one minute. There shall be no flashover over the insulator during the test.

**11.7.5** The test shall then be repeated at successively higher voltages in steps of 2·5 kV or 5 kV until the insulator is unable to withstand the applied voltage for one minute. The voltage, duly corrected as per Annex B, of the test immediately proceeding the last test shall be taken as "Maximum Wet Power Frequency Withstand Voltage".

### 11.8 Artificial Pollution Tests

**11.8.1** The artificial pollution test shall be carried out at 30 kV as per IS 8704 : 1978 using solid layer method of employing steam fog. The insulator shall be held in vertical position during test, except for sectioning insulator which shall be held in horizontal position.

**11.8.2** The quantity of salt deposited on the insulator shall also be determined so as to calculate the Equivalent Salt Deposit Density ( ESDD ). The results shall be expressed in the form of maximum withstand ESDD at 30 kV.

The test shall be conducted at the declared maximum withstand ESDD at 30 kV. The leakage current shall also be recorded during the test for record. If the insulator does not pass the test at the declared maximum withstand ESDD, the test may be repeated at lower values of ESDD.

**11.8.3** The insulator shall be deemed to have met the requirements of this test if the withstand ESDD at 30 kV is equal to or more than the specified value ( *see* 7 ).

### 11.9 Temperature Cycle Test

**11.9.1** The insulators for this test shall be complete with their metal parts. The insulator shall be quickly and completely immersed in a water bath maintained at a temperature of at least 70°C above that of cold water and left submerged for a period of $T$ minutes ( *see* Note ). The insulators shall then be withdrawn quickly and completely immersed, without being placed in an intermediate container, in a bath of cold water for the same period of $T$ minutes.

NOTE — The period $T$, in minutes, is given by the formula $T = 15 + 0{\cdot}7M$, where $M$ is the mass or insulator in kilograms.

**11.9.2** The complete test shall comprise five cycles, each cycle comprising two transfers, one each from hot to cold and cold to hot. The time taken to transfer the insulator from one bath to the other shall be as short as possible and shall not exceed 30 seconds. The quantity of water in the test tanks shall be large enough not to cause a temperature variation of more than 5°C in the water, when insulators are immersed.

**11.9.3** After the completion of the immersion, the insulators shall be examined to verify that the insulating parts have neither cracked nor the fittings loosened, and that the glaze is undamaged.

### 11.10 Mechanical Load Tests

**11.10.1** These tests would comprise tensile bending, eccentric loading, torsion tests as applicable in accordance with Table 2.

**11.10.1.1** *Tensile test*

The load shall be applied to the insulator fittings in line with the insulator axis. It shall be increased at a rate agreed to between the supplier and the purchaser to 60 percent of the specified minimum tensile failing load. It shall be maintained at this value for one minute and then raised at the same rate until fracture occurs. Fracture of the insulator shall not occur before the applied load reaches the minimum failing load under tension specified in Table 2.

**11.10.1.2** *Bending test*

One cap of the insulator shall be rigidly fixed in a suitable jig so that cap does not fail during the bending test and the failure takes place in the porcelain shell. The bending load ( *see* Table 2 ) shall be applied at the rate of 15-30 kgf/sec till failure, to the other end of the insulator in line with the diameter and in a direction perpendicular to the axis of the insulator. The failing bending moment shall be calculated by multiplying the load by the distance to the point of fracture.

**11.10.1.3** *Eccentric loading test*

This test is applicable for section insulator only. The tensile load ( *see* Table 2 ) shall be applied by a suitable jig in such a way that the line of application of load is 80 mm away from, and parallel to the axis of the insulator. Care shall be taken to ensure that during the test, the jigs do not move and the distance of the tensile load from the centre line of the insulator does not become less than 80 mm.

The load shall be raised at a rate agreed to between supplier and purchaser to 60 percent of specified minimum eccentric load. It shall be maintained at this value for 1 minute and then raised at the same rate until fracture occurs.

**11.10.1.4** *Torsion test*

The insulator shall be subjected to a torsional load avoiding all bending moment. The torsion test load shall be applied gradually starting from

a value not greater then half the specified minimum failing load and failure shall not take place below the specified minimum failing load in Table 2. The load shall then be increased to the failing load which shall be recorded.

**11.10.1.5** *Routine mechanical load test*

The test shall be conducted on all the insulators by the manufacturers and records maintained. The insulators shall be subjected for a duration of one minute, to a tensile ( or eccentric, in case of sectioning insulator ) load equal to 60 percent of the specified minimum breaking load. The load shall be applied under the conditions, prescribed in **11.10.1.1** or **11.10.1.3**. Any insulator which fractures, or the fittings of which looses or crack or become visibly deformed shall be rejected. Marking of the fittings at the point of contact with the connections to the testing machine shall not be regarded as deformation.

NOTES

1 The value of 60 percent which is generally accepted and may be modified by agreement between the purchaser and the supplier.

2 Immediately after each assembled insulator has passed the mechanical routine test, an adhesive label signifying this shall be affixed to the porcelain, adjacent to the label relating to the ultrasonic test. Alternatively, indelible stamping on the metal cap may be done.

3 The rejection rate shall be recorded during inspection.

**11.11 Mechanical Performance Test**

The test shall be conducted in accordance with Annex D. The insulator shall meet the requirements given in **D-3.1**.

**11.12 Thermal Mechanical Performance Test**

The test shall be conducted in accordance with Annex E. The insulator shall meet the requirements given in **E-3.1**.

**11.13 Porosity Test**

**11.13.1** Porcelain fragements from the insulator shall be immersed in one percent alcoholic solution or fuchsin ( 1 g fuchsin in 100 g of methylated spirit ) under pressure of not less than 150 kg/cm$^2$ is not less than 1 800. The unglazed area of the fragments shall be at least 75 percent of its total surface and at least some of the fragments shall be taken from the central parts of the ends of insulators.

**11.13.1.1** The fragements shall then be removed from the solution, washed dried and broken. Examination with naked eye of the freshly broken surface shall not reveal any dye penetration. Penetration into small cracks formed during the initial breaking shall be neglected.

**11.13.2** *Routine Porosity Test*

The test shall be conducted by the manufacturer on each shell. The insulating part of each insulator shall be provided during manufacture with an extension having a diameter at least equal to that of the core and a length at least half this diameter. After firing, this extension shall be cut off, broken and several fragments selected from the central part. The insulator and the fragment shall be suitably marked for identification. The fragments shall be sujected to the porosity test as per **11.3**. The insulators corresponding to such fragments which fail in the test shall be rejected and broken. A record of rejection shall be maintained. The insulators whose fragments have passed the test shall be affixed with a label to this effect on the glazed portion which will not be covered by the end caps.

NOTE — The rejection rate shall be recorded during inspection.

**11.14 Ultrasonic Test**

This test shall be made on insulating part of each insulator after breaking off the extension piece and machining the ends, but before assembly of end caps. Immediately after each batch of porcelains has passed the ultrasonic test, an adhesive label signifying this shall be affixed to the porcelain in a position that will not be covered by the end caps. The frequency of the ultrasonic wave shall be between 0·8 and 5 megacycles per second. The speed of propagation of the waves shall be not less than 5 800 metres per second. This test shall be made along the axis of the insulator and also radially. Insulators disclosing cracks or internal flaws or porosity shall be rejected and destroyed. This test may also be conducted on the insulators after fitting the metal caps optionally.

NOTE — The rejection rate shall be recorded during inspection.

**11.15 Galvanization Test**

The uniformity, adherence and mass of zinc coating shall be tested in accordance with IS 2633 : 1986, IS 2629 : 1985, IS 6745 : 1972 respectively. Galvanization shall satisfy the requirements of IS 4759 : 1979 except in respect of weight of coating.

The minimum weight of coating shall be as below, excluding tapped and threaded portions:

All standard insulators .....610 g/m$^2$

All polluted zone insulators excepting hook of stay arm.....1 000 g/m$^2$

Hook of polluted zone insulators..... 750g/m$^2$.

For acceptance tests, measurement of mass of zinc coating may be made by using magnetic method.

### 11.16 Verification of Eccentricity

The porcelain body and metallic caps shall be well centered. Insulator sample after other test shall be examined by breaking porcelain near the caps to check the eccentricity of porcelain body and the metallic caps. In no case, the eccentricity should be more than 2 mm.

## 12 PACKING

**12.1** Insulators shall be supplied securely packed in wooden crates. Not more than two insulators shall be packed in a crate so as to facilitate manual loading and unloading.

**12.2** In case of the overseas supplies, packing shall be sea-worthy.

# ANNEX A

( *Clause* 2.1 )

## LIST OF REFERRED INDIAN STANDARDS

| *IS No.* | *Title* |
|---|---|
| 1367 ( Part 16 ) : 1979 | Technical supply conditions for threaded steel fasteners : Part 16 Designation system and symbols ( *second revision* ) |
| 1885 ( Part 54 ) : 1980 | Electrotechnical vocabulary : Part 54 Insulators |
| 2071 | Methods of high voltage testing : |
| ( Part 1 ) : 1974 | General definitions and test requirements |
| ( Part 2 ) : 1974 | Test procedures ( *first revision* ) |
| ( Part 3 ) : 1976 | Measuring devices |
| 2108 : 1977 | Blackheart malleable iron castings ( *first revision* ) |
| 2629 : 1985 | Recommended practice for hot-dip galvanising on iron and steel ( *first revision* ) |
| 2633 : 1986 | Methods for testing uniformity of coating of zinc coated articles ( *second revision* ) |
| 4218 | ISO metric screw threads : |
| ( Part 1 ) : 1976 | Basic and design profiles ( *first revision* ) |
| ( Part 2 ) : 1976 | Diameter pitch combinations ( *first revision* ) |
| ( Part 3 ) : 1976 | Basic dimensions for design profiles ( *first revision* ) |
| ( Part 4 ) : 1976 | Tolerancing system ( *first revision* ) |
| ( Part 5 ) : 1979 | Tolerances ( *first revision* ) |
| ( Part 6 ) : 1978 | Limits of sizes for commercial bolts and nuts ( diameter range 1 to 52 mm ) ( *first revision* ) |
| 4759 : 1984 | Hot-dip zinc coatings on structural steel and other allied products |
| 5517 : 1978 | Steels for hardening and tempering ( *first revision* ) |
| 6745 : 1972 | Method for determination of mass of zinc coating on zinc coated iron and steel articles |
| 8349 : 1977 | Deviations for untoleranced dimensions of malleable iron castings |
| 8704 : 1978 | Methods for artificial pollution test on high voltage insulators for use on ac system |
| 8765 : 1978 | Ceramic insulating materials for electrical purposes |
| 13134 : 1992 | Guide for the selection of insulators in respect of pollution conditions |
| 13305 : 1992 | Permissible limits of visual defects for insulating porcelains for electrical circuits |

# ANNEX B

( *Clauses* 4.2, 11.5.1, 11.6.1.2, 11.6.2.3, 11.7.1, 11.7.3 *and* 11.7.5 )

## CORRECTION OF TEST VOLTAGES FOR ATMOSPHERIC CONDITIONS

### B-1 GENERAL

**B-1.1** Variations in barometric pressure and in humidity of the atmosphere cause variation in the electric strength of the air and hence also in the flashover voltage of insulators exposed to the air.

### B-2 CORRECTION FACTOR

**B-2.0** When the atmospheric conditions in the neighbourhood of the insulator during the test differ from the reference conditions, adjustments should be made to certain of the test voltages by the application of the following correction factors in accordance with Table 6.

**Table 6 Correction of Voltages for Atmospheric Conditions**

| Test | Adjustment Required |
|---|---|
| Visible discharge test ( Power-frequency voltage ) | Voltage applied shall be the appropriate value specified in Table 1 multiplied by $k$ and divided by $a$. |
| Impulse voltage withstand test | Voltage applied shall be the appropriate value specified in Table 1 multiplied by $k$ and divided by $h$. |
| Fifty-percent dry impulse flashover test | Measured voltages shall be divided by $k$ and multiplied by $h$. |
| Wet one-minute power-frequency withstand test | Voltage applied shall be the appropriate value specified in Table 1 multiplied by $k$. |
| Wet-power-frequency flashover test | Measured voltage shall be divided by $k$. |

**B-2.1** Correction factor for air density ($d$):

$$d = \frac{0{\cdot}289\,p}{273 + t}$$ ( $d$ lies between 0·95 to 1·05 )

where

$p$ = Atmospheric pressure in millibars, and

$t$ = Temperature in degrees Celsius.

**B-2.1.1** For a wider range of density and for higher accuracy, instead of $d$, the factor $k$ shall be used as under. The values of $k$ corresponding to factor $d$ are given below:

| $d$ | $k$ |
|---|---|
| 0·70 | 0·72 |
| 0·75 | 0·77 |
| 0·80 | 0·82 |
| 0·85 | 0·86 |
| 0·90 | 0·91 |
| 0·95 | 0·95 |
| 1·00 | 1·00 |
| 1·05 | 1·05 |
| 1·10 | 1·00 |
| 1·15 | 1·13 |

**B-2.2 Correction Factor for Humidity ($h$)**

Figure 10 gives the absolute humidity value for wet and dry bulb temperatures ( when the velocity of air over the wet bulb exceeds 3 metres per second ) for better the standard atmospheric pressure of 1 013 millibars. For accuracy, a correction should be applied to absolute humidity value obtained from Fig. 10 for any deviation of ambient atmospheric pressure from the standard value of 1 013 millibars. This correction should be obtained from Fig. 11 as follows.

**B-2.2.1** Locate the point corresponding to the deviation of ambient atmospheric pressure from 1 013 millibars on the left hand side top corner by a straight line. Then locate the point on the curve in Fig. 11A corresponding to the observed value of the difference of dry and wet bulb temperature. Draw a vertical line through this point to intersect the straight line drawn in Fig. 11B. Read the correction to be applied to humidity from the right hand side of Fig. 11B corresponding to the point of intersection. This correction is positive for a positive deviation and negative for negative deviation, from the standard atmospheric pressure.

**B-2.2.2** For the corrected value of absolute humidity thus obtained, the correction factor $h$ of Table 6 shall be determined from Fig. 12.

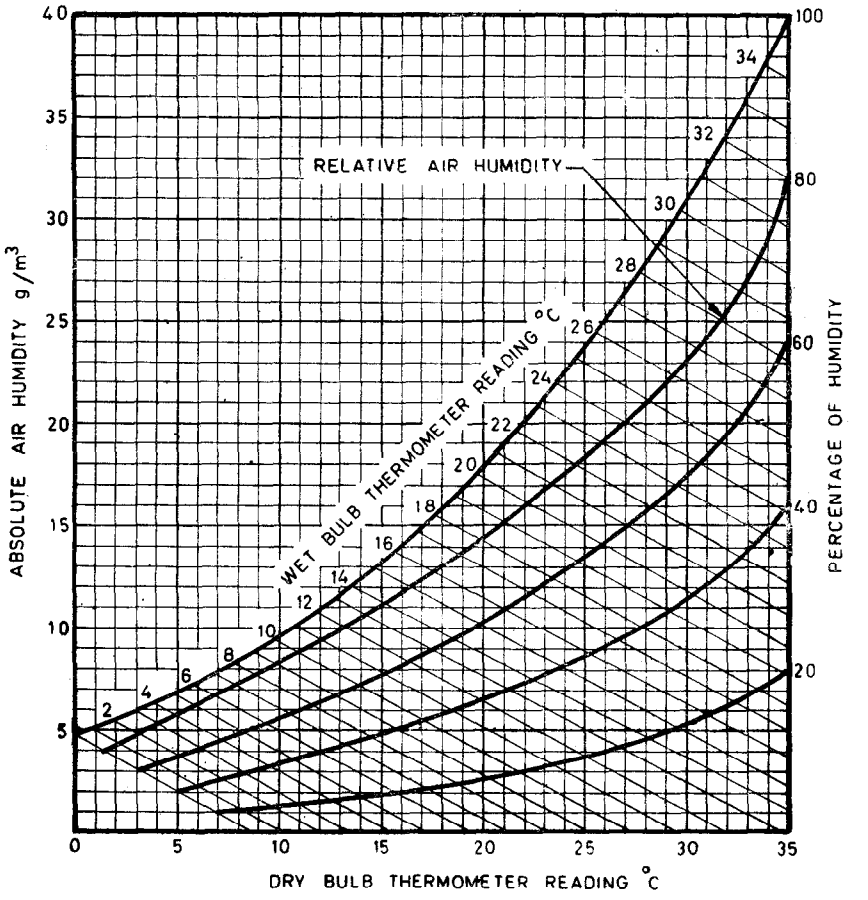



FIG. 10 ABSOLUTE AIR HUMIDITY AS A FUNCTION OF THE DRY BULB AND WET BULB TEMPERATURE

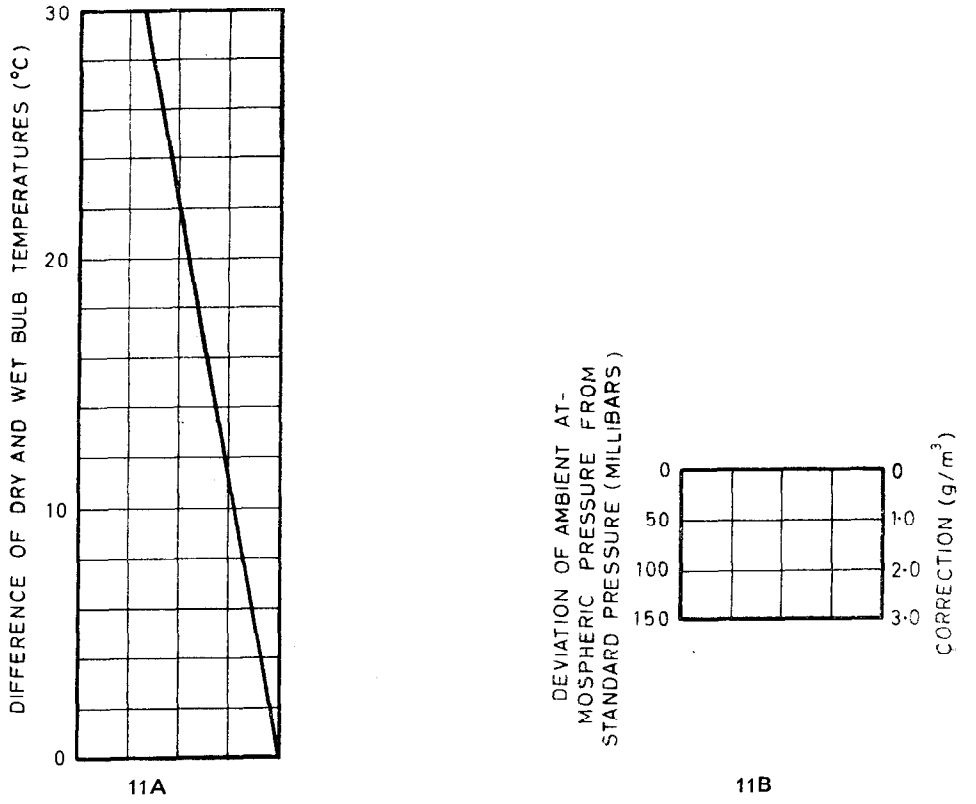
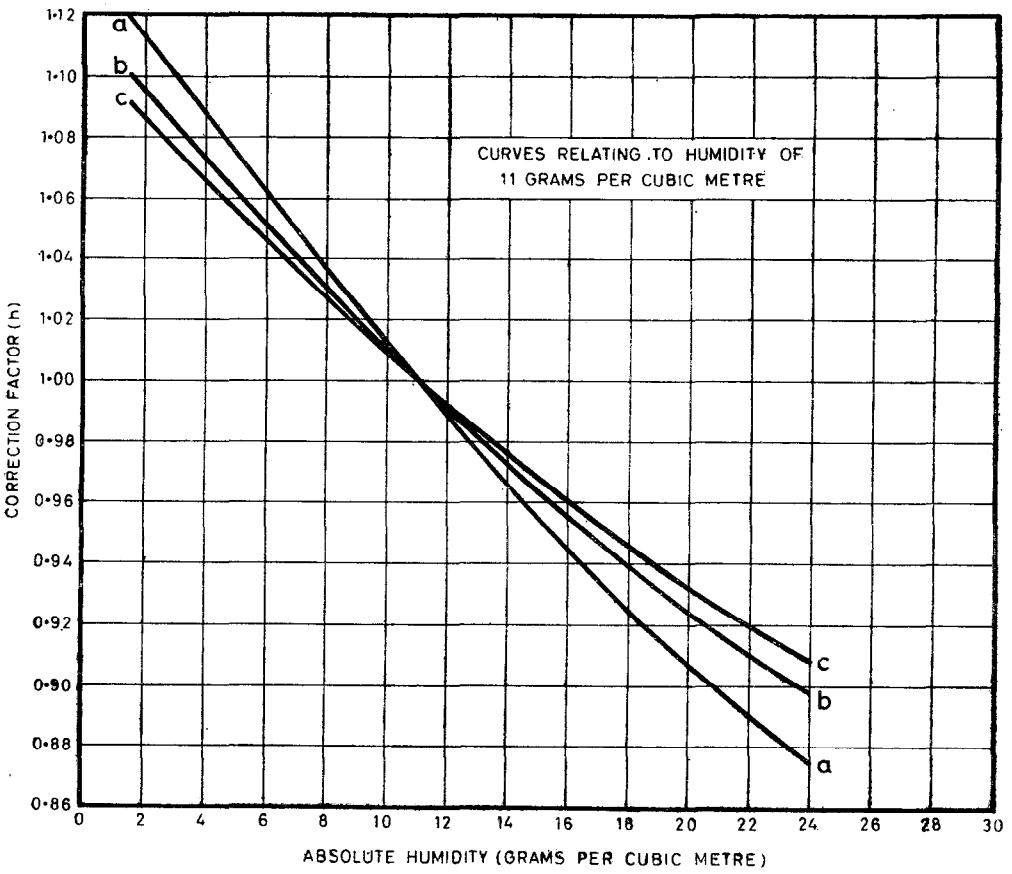



FIG. 11 CORRECTION TO ABSOLUTE HUMIDITY FOR VARIATION IN PRESSURE




Curve *a* applies for power frequency tests at approximately 50 c/s.
Curve *b* applies for positive impulse tests.
Curve *c* applies for negative impulse tests.

FIG. 12 HUMIDITY CORRECTION FACTOR

# ANNEX C

( *Clauses* 11.5.1, 11.6.1.1, 11.6.2.1 *and* 11.7.1 )

## GUIDANCE ON HIGH VOLTAGE TESTS

### C-1 ARRANGEMENT OF INSULATOR

#### C-1.0 General

The insulator shall be clean and dry and in thermal equilibrium with its surroundings.

#### C-1.1 Vertical Insulators

**C-1.1.1** The insulators shall be hung vertically from an earthed support by means of a wire rope or metal rod. The distance between the top of the insulator cap and the point of support shall not be less than one metre. At the lower end of the insulator a metal rod about one metre long shall be attached to the insulator and maintained in vertical position.

**C-1.1.2** No object shall be nearer to the axis of the insulator than one metre or 1·5 times the length of the insulator whichever is the greater.

**C-1.1.3** The test voltage shall be applied between the metal rod at the bottom of the insulator and the earthed point of suspension.

#### C-1.2 Horizontal Insulators

**C-1.2.1** The insulator shall be anchored by means of a cable or metal rod connected to earth. The distance between the top of the insulator cap and the point of anchorage shall not be less than one metre.

**C-1.2.2** The other end of the insulator shall be provided with a metal rod about one metre long and the whole arrangement maintained in an approximately horizontal position by any convenient means. No object shall be nearer to the axis of the insulator than one metre or 1·5 times the length of the insulator whichever is the greater.

**C-1.2.3** The test voltage shall be applied between the end of the metal rod and the earthed point of anchorage.

### C-2 HIGH VOLTAGE TEST

**C-2.1** The high voltage test shall be made in accordance with IS 2071 ( Part 1 ) : 1974, IS 2071 ( Part 2 ) : 1976 and IS 2071 ( Part 3 ) : 1976.

### C-3 PRECAUTIONS AGAINST EXCESSIVE HUMIDITY

**C-3.1** Special precautions shall be taken to avoid condensation on the surface of the insulator, specially when the relative humidity is high. For example, the insulator shall be maintained at the ambient temperature of the test location for sufficient time for thermal equilibrium to be reached before the test starts.

**C-3.1.1** Except by agreement between the manufacturer and the purchaser, test shall not be made if the relative humidity exceeds 85 percent.

## ANNEX D

( *Clause* 11.11 )

### MECHANICAL PERFORMANCE TEST

*Remarks* : The test is an acceptance test and shall be carried out when agreed between the manufacturer and the user. This test is a replacement of 24 hr mechanical test which is now discontinued. It is to be noted, however, that the proposed mechanical performance test seems to have an effect beyond the ordinary mechanical failing load test in the case of serious manufacturing faults only.

### D-1 GENERAL

**D-1.1** This test has an initial stage of mechanical loading and unloading, and a concluding stage of testing the insulator units to failure. The concluding stage is identical to an ordinary mechanical failing load test ( *see* **3.14** ). Such a failing load test also constitutes the basis for the mechanical performance test in judging the test results.

### D-2 METHOD

**D-2.1** During the initial stage of the test, the insulator units shall be subjected to a tensile load equal to 60 percent of the specified mechanical failing load. Unless otherwise agreed, the tensile load shall be applied and immediately removed four times in succession. On the same day, after loading and unloading, the insulator units shall be subjected individually to mechanical failing load test in accordance with **3.14**. Mechanical failing load shall be recorded.

### D-3 REQUIREMENTS

**D-3.1** The performance of the insulator units will be determined by a comparison of the failing load values and the fracture pattern obtained during the mechanical failing load test and the same test carried out as a final stage of the mechanical performance test defined here.

NOTES

1 The test may be more decisive if the 60 percent load is applied and removed more than four times in succession.

2 The insulator units may be coupled together in series and/or in parallel when subjected to the 60 percent load. When parallel coupled, the insulator units must be equally loaded.

3 The test may not give information on the internally stressed zone, if failure occurs in a metal part. In such cases, this test is not suitable for a sample test, but by agreement it may be used as a design test or special qualification test. It is possible to investigate the fundamental insulator design by using metal parts suitably strengthened so that failure occurs in the internally stressed zone of the insulator. Precaution should be taken that strengthening the metal parts does not affect the fundamental stress relationship.

# ANNEX E

( *Clause* 11.12 )

## THERMAL-MECHANICAL PERFORMANCE TEST

### E-1 GENERAL

**E-1.1** This test has a initial stage of thermal cycles together with mechanical loading and unloading, and a concluding stage of testing the insulator units to failure. The concluding stage is identical to an ordinary mechanical failing load test ( *see* **3.14** ). Such a failing load test constitutes the basis of the thermal-mechanical performance test in judging the test results.

### E-2 METHOD

**E-2.1** During the initial stage of the test, the insulator units shall be subjected to four 24 hours cycles of cooling and heating, and to a tensile load equal to 60 percent of the specified mechanical failing load ( *see* **3.14** ) whichever is applicable. The tensile load shall be applied to the insulator units at room temperature before starting the first thermal cycle.

**E-2.2** Unless otherwise agreed, each 24-hour cycle shall comprise a cooling to $-30 \pm 5$°C and a heating to $+40 \pm 5$°C. The temperature figures refer to the surrounding air. The temperature sequence shall be first cooling, then heating. The test equipment shall be such as to permit the minimum and maximum temperature each to be kept during at least for four consecutive hours of the temperature cycle.

**E-2.3** The tensile load shall be completely removed and re-applied towards the end of each heating period, the last one excepted.

**E-2.4** On completion of the fourth 24 hour cycle and cooling to room temperature, the tensile load shall be removed. On the same day, after this load removal, the insulator units shall be subjected individually to mechanical failing load test in accordance with **3.14**. The electro-mechanical or mechanical failing load according to **3.14** shall be accorded.

### E-3 REQUIREMENTS

**E-3.1** The performance of the insulator units will be determined by a comparison of the failing load values and the fracture pattern obtained during the mechanical failing load test and the same test carried out as the final stage of the thermal mechanical performance test defined here.

NOTES

1 The test procedure is schematically represented in Fig. 13.

2 This thermal-mechanical performance test has reference to the fundamental insulator design in respect of the internal stresses, and should not be repeated on types which differ in outward form only, that is the disc of the insulating part or the coupling ends of the metal fittings. Changes in internal design or in manufacturing processes are reasons for re-testing.

The test may not give information on the internally stressed zone if failure occurs in a metal part. In such cases, it is possible to investigate the fundamental insulator design by using metal parts suitably strengthened so that failure occurs in the internally stressed zone of the insulator. Precautions should be taken that strengthening the metal parts does not affect the fundamental stress relationship.

3 The insulator units may be coupled together in series and/or in parallel when subjected to the thermal cycles andthe 60 percent load. When coupled in parallel, the insulator units must be equally loaded.

4 Loose coupling pins, for example those used with insulators of the long rod type, should not be included in the mechanical test since they are not part of the internal design of the insulator ( *see* Note 2 ).

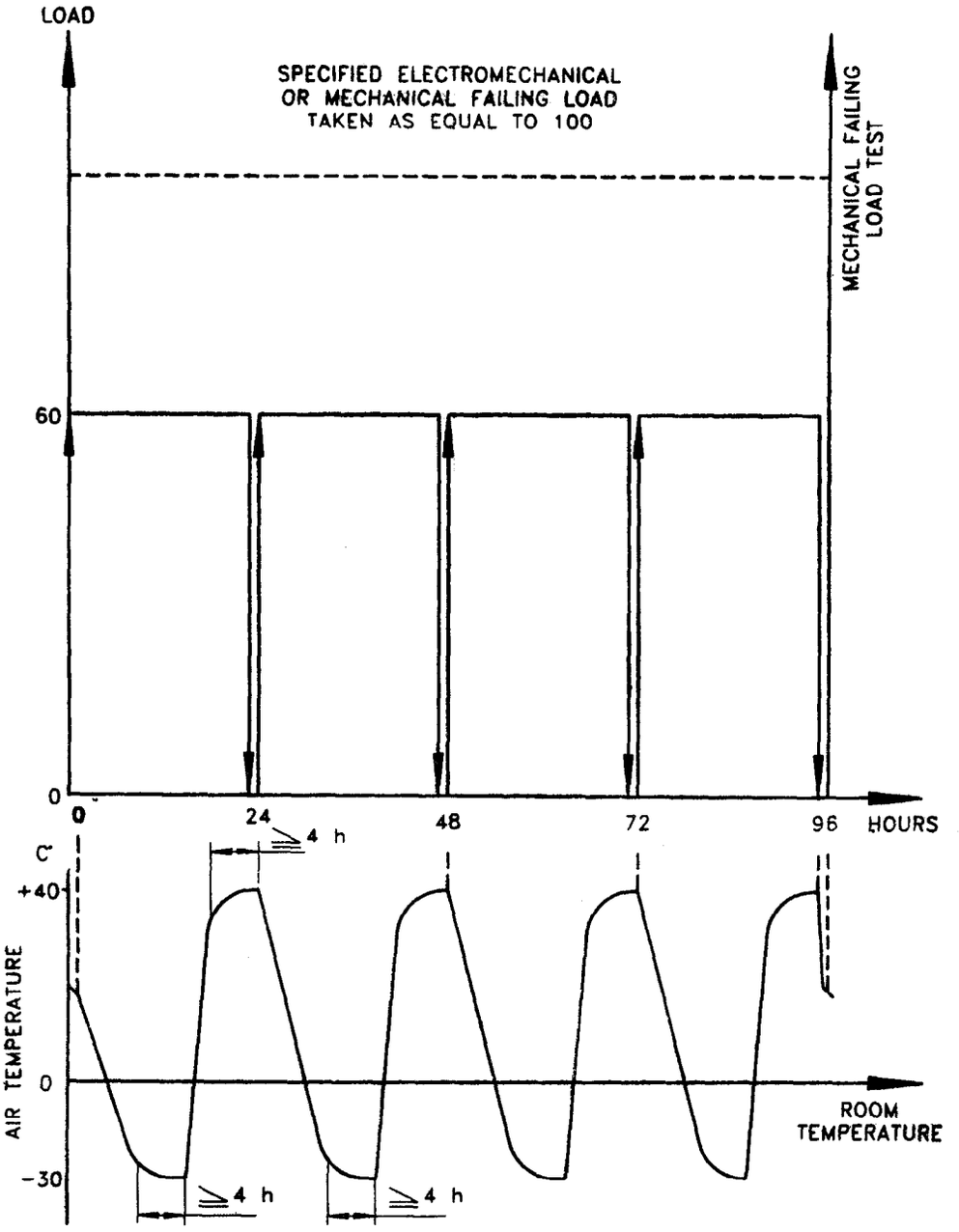



FIG. 13 SCHEMATIC REPRESENTATION OF THERMAL-MECHANICAL PERFORMANCE TEST

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